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descent from the Basket-maker is indicated by the dolicocephalic bead form and absence of cranial deformation; by the elaborateness of the sandal weaves; the presence of a degenerate type of twined-woven bag; and by the use of fur cloth instead of feather cloth. The absence of cotton from both cultures should be noted. Advances over the Basket-maker are seen in the appearance of pottery (albeit of a crude type), in the presence of permanent house-structures, and in the elaboration of the carrying straps.

The third culture is the one which we formerly called the Slab-house. As that term, based on a feature of the architecture, is equally applicable to the Post-Basket-maker we have discarded it and substitute the name Pre-Pueblo. This group is allied to the preceding one most closely apparently in house-types, and in the possession of pottery, though its characteristic wares are much the more highly developed of the two; it differs sharply from the Post-Basket-maker in the practice of skull deformation, in the possession of cotton, turkey-feather cloth and twilled basketry. Traits that it shares with the succeeding culture, the Cliff-dweller-Pueblo, are: skull deformation; decorated pottery; cotton; turkey-feather cloth; the bow.

From the above data it seems probable that the Basket-makers were the direct ancestors, both physically and culturally, of the Post-Basket-makers; the latter, however, had made considerable advances (houses, pottery). A direct line of descent from Post-Basket-maker to the Pre-Pueblo might be inferred from the similarity in house-types; but the Pre-Pueblo are in most respects much more nearly allied to their successors, the Cliff-dweller-Pueblo people, than they are to the earlier group.

To sum up: Basket-maker is probably ancestral to Post-Basket-maker; Pre-Pueblo to Cliff-dweller-Pueblo; the genetic relationship of Post-Basket-maker to Pre-Pueblo may be inferred, but is still doubtful. A more detailed knowledge of the material cultures of the two middle groups is necessary, as well as studies to determine whether or not skull deformation alone is capable of producing the marked appearance of brachycephaly exhibited by the crania of the two later groups.

### *THE OPEN MERCURY MANOMETER READ BY DISPLACEMENT INTERFEROMETRY<sup>1</sup>*

BY CARL BARUS

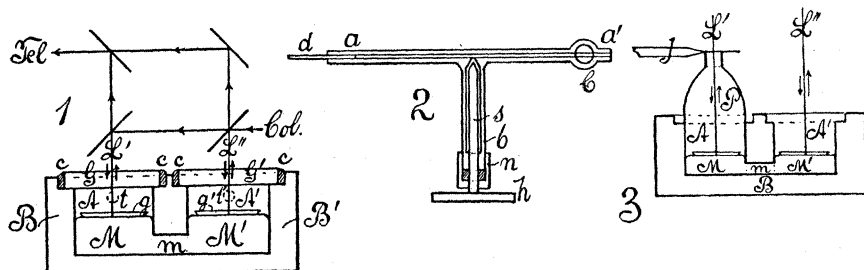
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1. *Apparatus.*—This is practically a U-tube,  $AmA'$ , figure 1, with wide shanks,  $AA'$ , connected by a channel,  $m$ , below.  $A$  and  $A'$  are cylindrical hollows, 2–3 cm. deep and about 5 cm. in diameter, cut in a rectangular

<sup>1</sup> Advance note from a report to the Carnegie Inst. of Washington, D. C.

block,  $BB'$ , preferably of iron. The connection  $m$  must also be large in section, so as to admit of rapid flow from  $A$  to  $A'$ . The U-tube is charged with mercury  $MmM'$ ,  $M$  and  $M'$  being as shallow as possible to counteract the tendency to vibration. Thin plane parallel glass plates,  $gg'$ , round discs of equal thickness and diameter, are floated on the mercury, which act as mirrors for the interferometer beams,  $L'$  and  $L''$ , and also materially check the tendency of the pool of mercury to vibrate. It would be desirable to be able to use the mercury surfaces at  $M$  and  $M'$  directly without the intervention of the plate; but within the city limits the fringes are unsteady and hard to find.



The top of the iron block  $BB'$  is recessed as shown, to receive the plane parallel glass plates  $GG'$ . These like  $gg'$  must be equally thick; otherwise the fringes will be multiplied and faint. The annular space  $cccc$  between  $G$  and  $B$  is filled with resinous cement, poured in in the molten state. The air space  $AA'$  shut off in this way communicates with the atmosphere by two tubulures,  $t$  and  $t'$ , in the front side.

The ray parallelogram of the quadratic interferometer of which  $L'L''$  are the interfering rays should be vertical. The displacements of the achromatic fringes of white light are read off by a telescope with an ocular micrometer (scale part 0.01 cm.). The fringes parallel to the divisions of the micrometer are conveniently made a scale part in size. The block  $BB'$  should be mounted separately from the interferometer. If it is placed on the base of the latter, all manipulations there shake the mercury in  $BB'$  and it is necessary to wait for subsidence. This, however, occurs very soon, so that the separate mounting is not absolutely necessary. Without manual interference the fringes are about as quiet as in a solid apparatus.

2. *Experiments.*—To test this apparatus the air space  $AA'$  was left with a plenum of air. With  $A'$  communicating with the atmosphere,  $A$  was joined through  $t$  and a filimentary capillary glass or metal tube, to an apparatus by which slight pressure could be applied. In the first trials I attempted to use a water manometer controlled by a micrometer screw; but the vibrations of the meniscus were at once impressed on  $MM'$  so that the fringes were hard to keep at rest. I then devised the apparatus shown in figure 2, which is merely an adaptation of the pin valve of an oxygen tank, with a good micrometer screw,  $s$ , and stuffing box,  $n$ . The

head  $h$  of the screw is graduated. The barrel  $b$  is at right angles to the tube  $aa'$ , which at  $a$  joins the capillary tube  $d$ , leading to  $t$  of figure 1. At the end  $a'$  there is a cock,  $C$ , which shuts off communication with the atmosphere. Thus when  $C$  is closed pressure is applied directly at  $A$ , figure 1, by rotating the head  $h$  in figure 2. This pressure is at once removed by opening  $C$ .

The apparatus worked surprisingly well. When  $C$  is closed and  $h$  rotated, the fringes may be placed anywhere in the field about as conveniently as with the micrometer screw at the mirror of the interferometer. There is, however, one difficulty which I have not thus far been able to remove. When the pressure increments exceed a certain small value, the plates  $gg'$  no longer rise and fall in parallel. The coincidence of images is destroyed and the fringes vanish. There is here a conflict with the capillary forces present at the edges of the disc. I endeavored to improve this by using small plates  $gg'$ , anchored near the centre of  $MM'$  by 4 loose threads. But the advantage was not marked. Fringes a scale part in size will not be available for more than 50 scale parts, being sharpest in the middle. This is about half the diameter of field of the ordinary telescope. Curiously enough, fringes from the free surfaces of mercury vanish in the same way, probably owing to surface viscosity of the mercury, not absolutely pure.

3. *Equations and Pressure Observations.*—If the cock  $C$ , figure 2, is closed and the temperature for brief intervals is considered constant, Boyle's law may be written (ignoring signs of increments)

$$\frac{dv}{V} - \frac{dV}{V} = \frac{dp}{p} = \frac{dh}{76} \quad (1)$$

where  $V$  is the total volume enclosed,  $dv$  the increment at the micrometer screw  $hs$ , and  $dV$  the corresponding decrement equivalent to the pressure decrement  $dp$ . If  $a$  is the area of the piston at  $g$   $dV = a dh/2$  and if  $V = aH$ ,  $H$  being the corrected air space at  $A$ , equation (1) becomes

$$\frac{dv}{V} - \frac{dh}{2H} = \frac{dh}{76} \quad (2)$$

But  $dh$  on the interferometer is equivalent to  $n$  fringes of wave-length  $\lambda$  so that  $dh = n\lambda/2$ . Hence, finally

$$dv = V \frac{\lambda}{2} \left( \frac{1}{76} + \frac{1}{2H} \right) n. \quad (3)$$

This equation gives a test of the trustworthiness of the gauge.

In the apparatus used the following constants were found by measurement:  $V = 66.8$  cm.<sup>3</sup>,  $a = 29.2$  cm.<sup>2</sup>,  $H = 2.29$  cm. The pitch of the screw was 0.073 cm. and its mean diameter 0.51 cm. Hence per turn  $dv = 0.073 \times 0.204 = 0.0149$  cm.<sup>3</sup> and  $dv/V = 10^{-4} \times 2.23$  per turn. The mean wave-length being  $\lambda = 6 \times 10^{-5}$  cm. equation 3 reduces to  $n = 3.2$  fringes per turn of the screw  $hs$ .

In the experiments fringes of  $1/2$  scale part were installed. In separate experiments immediately after closing the cock  $C$ , a half turn of the screw produced a displacement of 8.3, 8.0, 8.0, 8.5, 8.5 scale parts, as the average, therefore 16.4 scale parts per turn or about 33 fringes per turn. This agrees as closely as may be expected with the number computed.

The pressure increment per turn of screw is  $dp = n/2$  cm. of mercury or per turn of screw about  $10^{-3}$  cm. Per fringe, therefore,  $3 \times 10^{-5}$  cm. of mercury as anticipated. A range of about 2 or 3 turns of screw was possible with each fringe, i. e., the range of pressure measurement should be from  $3 \times 10^{-5}$  to  $3 \times 10^{-3}$  cm. of mercury.

Experiments of the same kind were made in great variety. There is no difficulty in using much larger fringes so that  $3 \times 10^{-6}$  cm. of mercury should be appreciable. By exhausting both sides of the U-tube the apparatus becomes a vacuum gauge. I did not, however, attempt much work with it as the present apparatus was not well adapted for the purpose.

*Air Thermometer.*—If the cock  $C$  is permanently closed, the air space  $A$  becomes the bulb of an air thermometer of approximately constant volume. In this way the heat produced by the rays of light  $L'$  may be measured. In a variety of experiments of the kind, the mean result was about 10 scale parts or 20 fringes in a lapse of 210 seconds. If  $\tau$  denotes absolute temperature, the intrinsic equation may now be written

$$\frac{dp}{p} + \frac{dv}{V} = \frac{d\tau}{\tau}$$

which reduces as above to

$$\frac{dh}{76} + \frac{dh}{2H} = \frac{d\tau}{\tau}.$$

Thus if  $\tau = 300^\circ$

$$d\tau = \tau n \frac{\lambda}{2} \left( \frac{1}{76} + \frac{1}{2H} \right) = 10^{-3} \times 2.1n^\circ \text{ C.}$$

and for  $n = 20$  in 210 seconds

$$d\tau = 0.042^\circ \text{ C.}$$

or the heating produced was  $2 \times 10^{-4}^\circ \text{ C.}$  per second. Whether, supposing  $AA'$  to be filled with water, a pyrheliometer may be constructed on this principle I have yet to learn.

Other interesting results of the same kind might be mentioned. Thus if the screw stopcock, figure 2, is closed quickly ( $C$  being open) there is always a decided increment of pressure. In other words in consequence of the viscosity of air, the fine space at the plug is virtually a closure before the screw is checked by an actual closure.

If the glass plates  $G$  are removed and the air space  $A$  is closed by a pipe,  $P$ , tapering to a neck as in figure 3, it becomes a closed organ pipe adapted for the measurement of acoustic pressure. It may be blown by an adjustable embouchure,  $j$ , described heretofore (*Science*, 53, 1921 (47)), or

by resonance. Thus far, however, I have failed to find more than a pipe sounding under slightly increased or slightly diminished pressure.

Again if the apparatus, figure 3, is made of insulating material ( $P$ ,  $j$  removed) and is provided with a disc electrode parallel and coaxial with the surface  $M$  used as a counter-electrode, the combination becomes an absolute electrometer of considerable interest. All the usual experiments of the electroscope may be performed by means of it, with the potential readings immediately in absolute units.

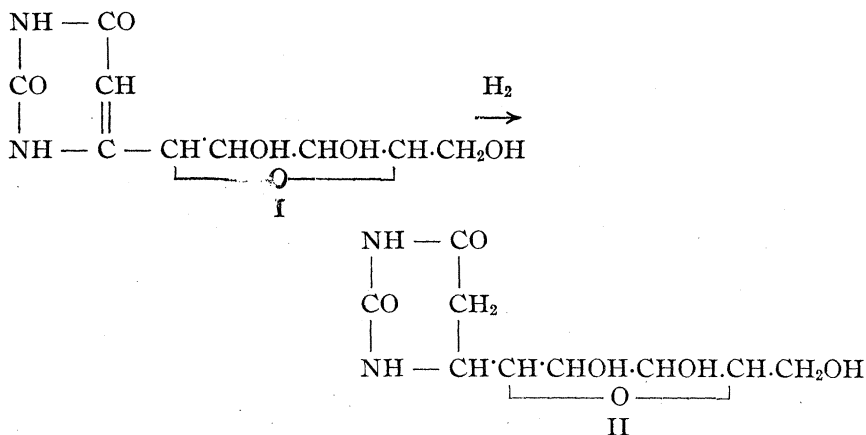
### STUDIES ON CATALYSIS. I—THE REDUCTION OF URACIL TO HYDROURACIL

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Levene and LaForge,<sup>1</sup> in 1912, made the interesting observation that the nucleoside *uridine* I, which is obtained by hydrolysis of nucleic acid, is reduced practically quantitatively to dihydrouridine II by Paal's<sup>2</sup> method of catalytic reduction, namely, by means of colloidal palladium and hydrogen. This transformation involves an addition of hydrogen at the double bond joining positions 4 and 5 in the uracil nucleus and the change is represented as follows:



As far as the writers are aware, this is the first and only case described in the literature of the application of a catalytic process of reduction in the pyrimidine series. A striking fact revealed by the work of these investigators is the remarkable ease with which the sugar can be detached from this dihydrouridine molecule II by hydrolysis with acids. The corresponding uridine combination I is very stable and resistant to hydrolysis.